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POWER SUPPLIES UNLIMITED

TC-Series

NJE CORPORATION Kenilworth, New Jersey

INSTRUCTION MANUAL

TRANSISTOR-DRIVEN, SILICON CONTROLLED RECTIFIER

REGULATED POWER SUPPLY

MODEL TC

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WARNING!

THIS EQUIPMENT EMPLOYS VOLTAGES WHICH ARE DANGEROUS AND CAN BE FATAL IF CONTACTED BY OPERATING PERSONNEL. EXTREME CAUTION SHOULD BE EXERCISED WHEN WORKING WITH THIS EQUIPMENT.

CORRESPONDENCE AND ORDERING SPARE PARTS

1. Each NJE Power Supply has an identification label located in the rear of the unit which bears the Model and Serial number of the particular unit.

2. When requesting Engineering data, reference should be made to the Model and Serial number.

3. When ordering spare parts, the information outlined in above item 2 should be given in addition to the NJE Part No. that appears on the replaceable parts list in Section (V).

SECTION I

DESCRIPTION

1-1. GENERAL- The NJE TC Transistor-Driven Silicon Controlled Rectifier Regulated Power Supply is designed for use in applications requiring a well regulated and stable source of DC power at high values of current.

1-2 ELECTRICAL SPECIFICATIONS:

See Table 1-1 for individual Model rating

Output Voltages and Output Current:	Voltages can be increased to 120% of maximum rating provided output current is rerated linearly to zero at 120% of maximum output voltage rating. See Table 1-1 for individual rating.
Static Regulation:	Load ±0.25% Line ±0.5%
Ripple:	1% RMS from 80% to 100% of maximum rated output voltage. Derate linearly to 1.5% at minimum output voltage.
Transient Response:	Transient response is best described by the "turn-around time" parameter. For TC line models, the output voltage begins its recovery cycles in less than 30 milliseconds.
Meters:	Output voltmeter and ammeter rated accurate to 2% of full scale rating, are supplied on the front panel for the TC models and no meters are provided for the ETC models.
Polarity:	Output may be floated up to 500V peak from ground. Either polarity may be grounded to chassis by means of terminal provided.
Duty:	Continuous at ambient temperatures from 0°C to 50°C. Current must be derated linearly to 0 at 85°C.
Remote Sensing:	Sensing terminals, separate from the output terminals, provide sensing and load regulation against the voltage at the load rather than the voltage at the power supply terminals. This eliminates the otherwise unavoidable load regulation due to the resistance of the wire connecting the supply to the load. This feature does not eliminate voltage excursions resulting from load transients through longline impedance.

Remote Programming: The output voltage may be accurately controlled from a remote point, if desired, by varying the resistance across two "Remote Program" terminal provided.

Series Operation: Two or more units may be operated in series to provide higher voltage output at rated current.

Termination: A barrier type terminal strips at the rear of the unit provides terminals for input, output, remote sensing, remote programming, and ground. Positive and Negative output also available on front panel binding posts, except for 50 ampere models.

Stability: ± 1/2% for 24 hour day under laboratory conditions. AC line fuse protects against overload, short circuits and internal failures.

Model No.	Output		Input Power		
	Volts	Amps	Volts	Freq	Amps.
TC14-15	5-14	0-15	105-125	47-65	3.2
TC32-10	10-32	0-10	105-125	47-65	4.0
TC52-6	20-52	0-6	105-125	47-65	4.9
TC80-4	25-80	0-4	105-125	47-65	5.5
TC14-30	5-14	0-30	105-125	47-65	7.3
TC32-20	10-32	0-20	105-125	47-65	8.8
TC52-12	20-52	0-12	105-125	47-65	9.0
TC80-8	25-80	0-8	105-125	47-65	8.0
TC100-6	40-100	0-6	105-125	47-65	9.0
TC32-30	10-32	0-30	208/220 [1, 2]	47-65	15.7
TC32-50	10-32	0-50	208/220 [1, 2]	47-65	13.5
TC52-30	20-52	0-30	208/220 [1, 2]	47-65	12.5
TC80-20	25-80	0-20	208/220 [1, 2]	47-65	12.0

Basic Rating of Power Supply
Table 1-1

Notes

1. The units may be operated at 47CPS input frequency with a 50% derating of the ripple specification.

 2. Single Phase

1-3. MECHANICAL SPECIFICATIONS:

Mounting: Designed for 19" rack mounting.

Dimensions: See Table 1-2

Panel Elements:

Front Panel

Output Adjust Control
AC Indicator Lamp
AC line switch
AC line fuse
Pos & Neg Binding Posts (except 50A models)
Ammeter (On TC Models only)
Voltmeter (On TC Model only)

Rear Deck

Terminal Board

Finish: Exterior is dark grey enamel. Panel is dark grey with white trim, Interior finish is paint, plating, or anodizing as required.

Weight: See Table 1-2.

Model No.	Dimensions H x W x D	Net Wgt Lbs.	Approx. Shipping Weight Pounds
TC14-15	3-1/2" x 19" x 15"		65
TC32-10	3-1/2" x 19" x 15"		55
TC52-6	3-1/2" x 19" x 15"		55
TC80-4	3-1/3" x 19" x 15"		55
TC14-30	5-1/4" x 19" x 16-5/8"		80
TC32-20	5-1/4" x 19" x 16-5/8"		75
TC 52-12	5-1/4" x 19" x 16-5/8"		75
TC80-8	5-1/4" x 19" x 16-5/8"		75
TC100-6	5-1/4" x 19" x 16-5/8"		80
TC32-30	7 x 19" x 16-5/8"		175
TC 32-50	10-1/2" x 19" x 16-5/8"		175

Model No.	Dimensions H x W x D	Net Wgt Lbs.	Approx. Shipping Weight Pounds
TC52-30	10-1/2" x 17" x 16-5/8"		175
TC80-20	10-1/2" x 17" x 16-5/8"		170

Size and Weight of Power Supply

Table 1-2

SECTION II

INSTALLATION AND OPERATION

2-1. UNPACKING. The power supply is shipped in a cardboard carton which is located on sufficient insulation in a heavy-duty shipping carton. Aside from normal precaution against damage to the unit in opening the cartons and removing the unit, no special procedures are required. The carton should be opened immediately upon receipt and the contents inspected for shipping damage. The Power Supply was checked electrically and mechanically before it left the factory, and is warranted to be in perfect operating condition. This guarantee does not cover possible damage incurred during shipment. Therefore, any evidence of mishandling, such as broken, deformed or missing parts, should be brought to the attention of the transportation company and a claim should be entered. Remove top cover plate and inspect all components and wiring, both on the chassis and panel, as well as the mechanical condition of the housing.
The literature packed with the supply should be removed and held for reference in operating the equipment.

2-2. INSTALLATION. The supply can be mounted in any convenient location for bench use, and requires no adjustment or modification for such application. If the unit is to be installed in a housing, it is recommended that the rack or cabinet used be equipped with angle brackets, shelves, or slides to receive the unit, rather than suspending the assembly by its front panel mounting screws. The panel is notched for standard rack mounting.

Note

On high power unit adequate ventilation must be provided for the forced air cooling system.

2-2.1 When the unit has been properly placed in position, or mounted in its rack and secured in place by the panel screws, refer to Figure 2-1A for low power units, Figure 2-1B for high power units and make the following connections.

Item 1A - Output Grounding Using no. 16 AWG wire, connect either the positive (TB1-7) or negative (TB1-5) DC output terminal of the supply (depending upon desired output polarity) directly to the chassis ground terminal (TB1-8) at the barrier strip on the rear of the chassis, and connect the ground terminal to the system ground.

Item 1B - Output Grounding Using no. 16 AWG wire or larger, connect either the positive (TB2-2) or negative (TB2-4) DC output terminal of the supply (depending upon desired output polarity) directly to the chassis ground terminal (TB2-3) at the barrier strip on the rear of the chassis, and connect the ground terminal to the system ground.

Note

If it is necessary that the power supply circuit float above or below ground, it is recommended that the output terminal should be connected to the chassis ground terminal by a 0.1 microfarad 600 W VDC capacitor in place of the direct connection. Use of this by-pass capacitor will improve the stability of the circuit in the ungrounded condition, and reduce the effect of external interference and hum.

Item 2A - Output Connections: Connect the positive and negative output terminals (TB1-7 and TB1-, respectively) to the corresponding terminals of the external load, using No. 10 AWG wire or larger if distances are involved.

Item 2B - Output Connections: Connect the positive and negative output terminals (TB2-2 and TB2-4, respectively) to the corresponding terminals of the external load, using No. 10 AWG wire or larger if distances or heavy currents are involved.

Item 3A - Remote Sensing: Connect the positive sensing terminal (TB1-7) to the positive terminal of the remote load, and the negative sensing terminal (TB1-10) to the negative terminal of the remote load. A twisted pair of No. 20 AWG (or larger) wire should be used for these connections. If accurate regulation at the remote load is not essential, then the sensing leads may remain connected directly at the power supply output terminals i. e., jumper (TB1-6) and TB1-7) and jumper (TB1-9) and (TB1-10).

Item 3B - Remote Sensing: Connect the positive sensing terminal (TB2-1) to the positive terminal of the remote load, and the negative sensing terminal (TB2-5) to the negative terminal of the remote load. A twisted pair of No. 20 AWG (or larger wire should be used for these connections. If accurate regulation at the remote load is not essential, then the sensing leads may remain connected directly at the power supply output terminals; i. e., jumper (TB2-2 and TB2-1) and jumper (TB2-4 and TB2-5).

Item 4-A & B - Output Capacitor Connections: The power supply has been shipped from the factory with the appropriate filter capacitors internally wired. This arrangement is satisfactory for most applications. However, if better transient and dynamic characteristics are required, further improvement can be effected by using an independent capacitor (available from the factory) mounted physically as close to the ultimate load as is practical. Consult the NJE Engineering Department on special transient problems

Item 5A- Remote Control-Programming: Terminals (TB1-4) and (TB1-5) are provided for the insertion in series of a remote control programming resistor. This circuit has a sensitivity of about 140 ohms per volt. When the panel voltage adjustment is set to zero, the output voltage may be accurately controlled from zero to rated voltage by varying the remote resistance.

Item 5B- Remote Control-Programming: Terminals (TB1-2) and (TB2-5) are provided for the insertion in series of a remote control programming resistor. This circuit has a sensitivity of about 140 ohms per volt. When the panel voltage adjustment is set to zero, the output voltage may be accurately controlled from zero to rated voltage by varying the remote resistance.

Item 6A- Dualling: Two supplies may be operated in series (with an overall current derating of 10%). For proper interconnection and wiring of the individual supplies and the load, refer to figure 2-2A.

Item 6B-Dualling: Two supplies may be operated in series (with an overall current derating of 10%). For proper interconnection and wiring of the individual supplies and the load, refer to figure 2-2B.

Item 7A- Input Connections: Connect the deactivated input line (115 volts nominal, 60 cycles single phase) to the AC input terminals (TB1-1 and TB1-3) on the barrier strip, using No. 14AWG wire and connect the equipment safety ground of power system to ground terminal (TB1-2).

Item 7B-Input Connections: Connect the deactivated input line (208/220 volts nominal, 60 cycles, single phase) to the AC input terminals (TB1-1 and TB1-3) on the barrier strip, using No. 14 AWG wire or larger and connect the equipment safety ground of power system to ground terminal (TB1-2).

2-3 OPERATION. The following checklist should be reviewed before proceeding to make the unit operational.

1. Sensing connection
2. Load connection
3. Input connection
4. Programming connection
5. Grounding for input and output
6. Output Adjust Control completely counter clockwise
7. AC control switch in Off position.

2-3.1 The unit can now be made operational. Refer to Figure 2-1 for location of the controls.

Step 1. Energize AC input line.

Step 2. Set AC control switch (S1) in ON position.

Note: The AC indicator lamp on front panel will light.

Step 3. Slowly rotate OUTPUT ADJUST Control (R4) clockwise until desired voltage level is reached.

Note: Monitor the load current to avoid overload.

2-3.2 If the required voltage or current value within the rating of the unit cannot be achieved, de-energize the input line and check connection on the rear terminal strip before referring to the troubleshooting paragraphs of this Manual.

MODEL 14-15	MODEL 52-12	
32-10	80-8	REFER TO ITEM 1A TO 7A FOR CROSSCONNECTION
52-6	100-6	
80-4	32-30	
14-30		
32-20		

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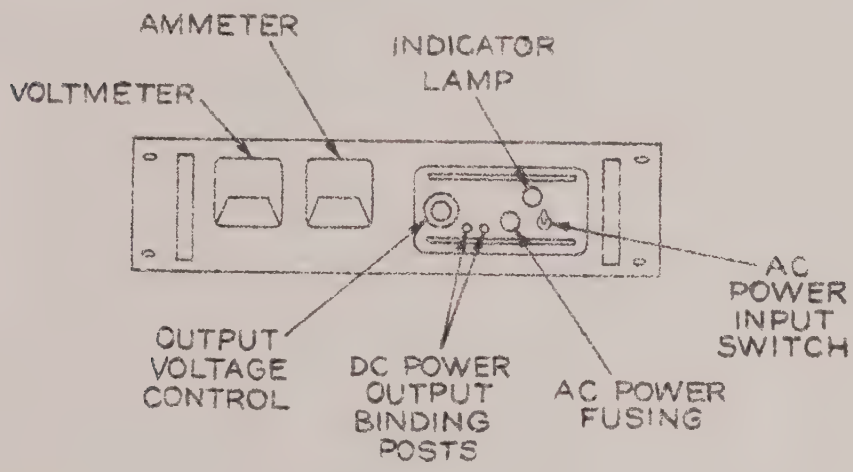
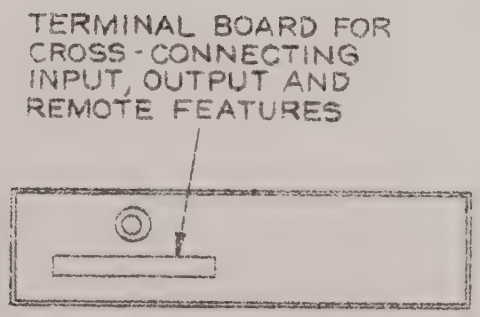


FRONT VIEW

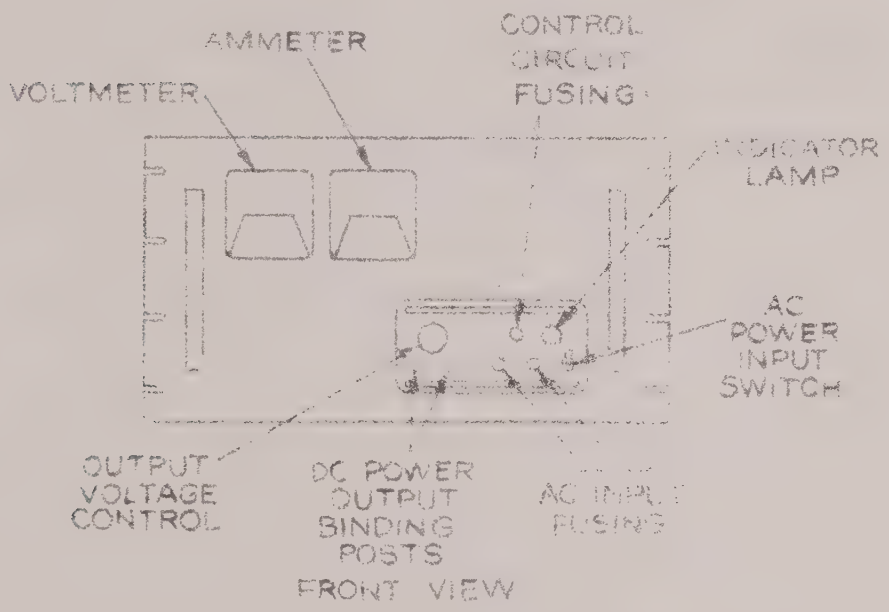


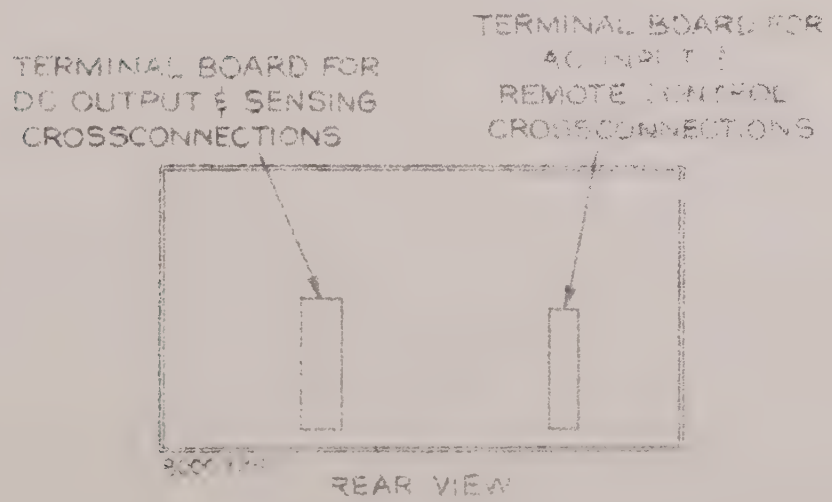
REAR VIEW

LOCATION OF THE OPERATIONAL ELEMENTS
(LOW POWER UNITS)

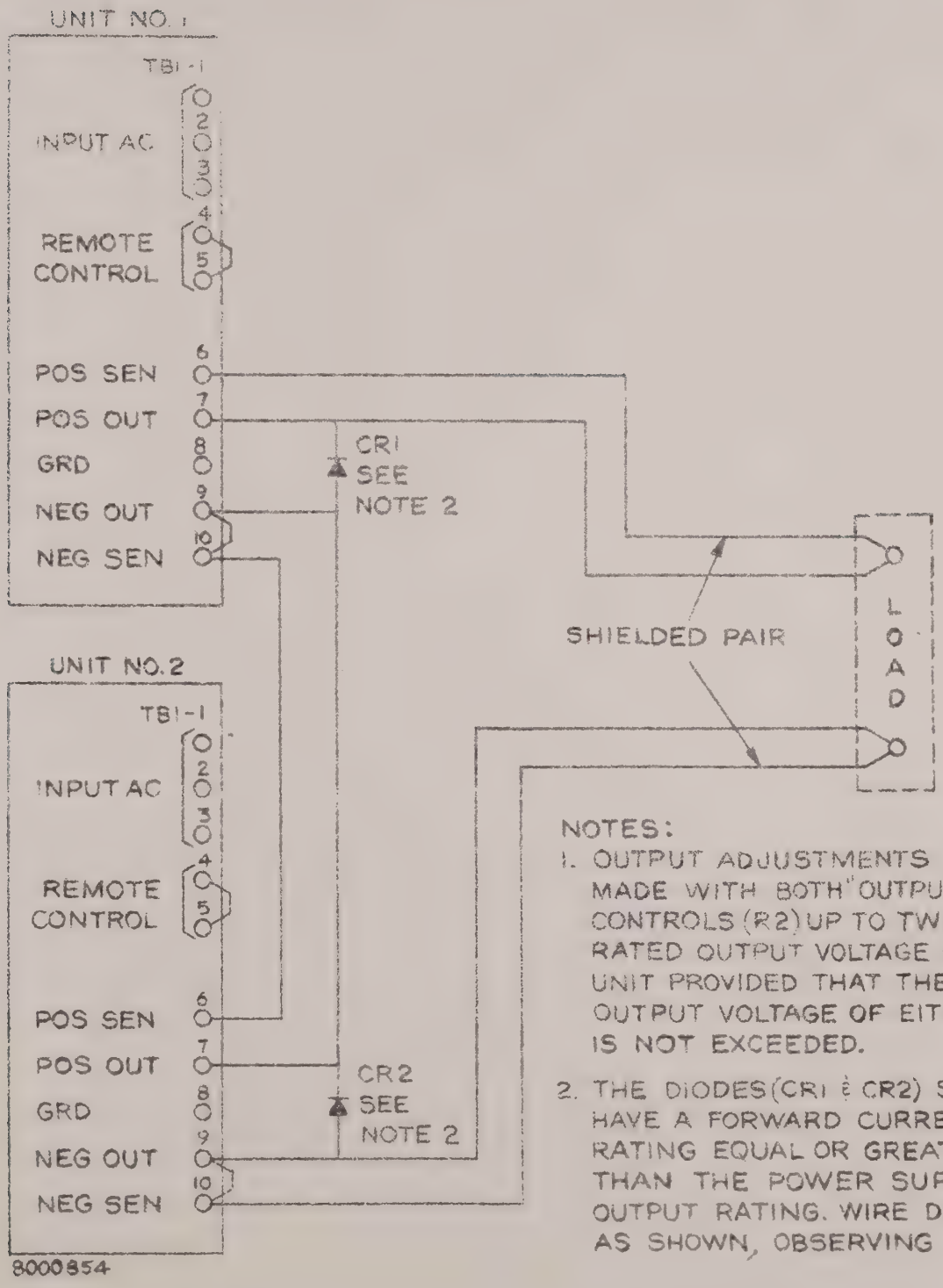
FIG. 2-1A

MODEL	
32-50	REFER TO ITEMS 18 TO 78 FOR CROSSCONNECTION
52-30	
80-20	




TERMINAL BOARD FOR DC OUTPUT & SENSING CROSSCONNECTIONS
TERMINAL BOARD FOR AC INPUT & REMOTE CONTROL CROSSCONNECTIONS
REAR VIEW

LOCATION OF THE OPERATIONAL ELEMENTS
(HIGH POWER UNITS)

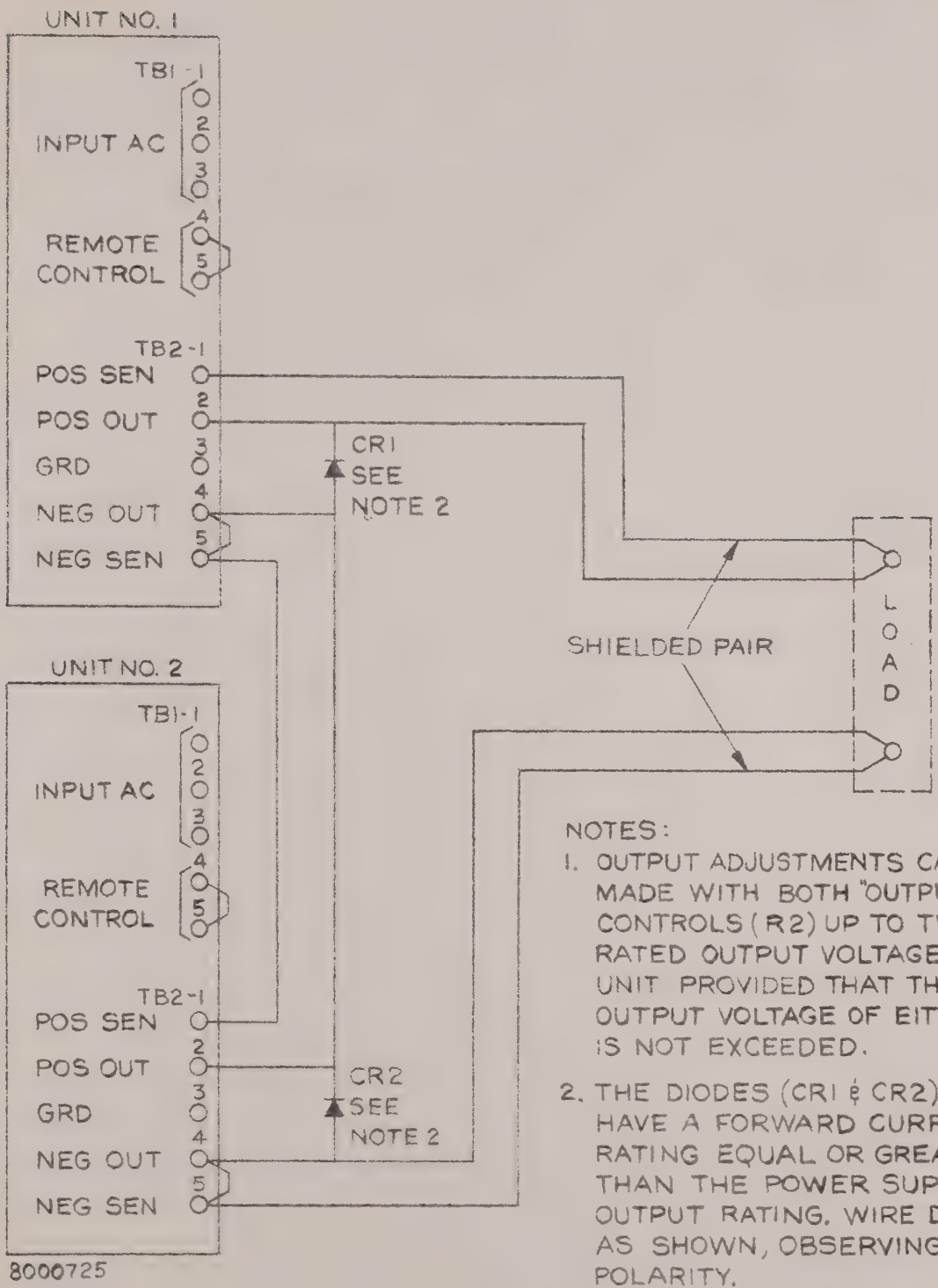


NOTES:

1. OUTPUT ADJUSTMENTS CAN BE MADE WITH BOTH "OUTPUT ADJUST" CONTROLS (R2) UP TO TWICE THE RATED OUTPUT VOLTAGE OF EITHER UNIT PROVIDED THAT THE RATED OUTPUT VOLTAGE OF EITHER UNIT IS NOT EXCEEDED.
2. THE DIODES (CR1 & CR2) SHALL HAVE A FORWARD CURRENT RATING EQUAL OR GREATER THAN THE POWER SUPPLY OUTPUT RATING. WIRE DIODES AS SHOWN, OBSERVING POLARITY.

SERIES CONNECTION (LOW POWER UNITS)

FIG. 2-2A



NOTES:

1. OUTPUT ADJUSTMENTS CAN BE MADE WITH BOTH "OUTPUT AJUST" CONTROLS (R2) UP TO TWICE THE RATED OUTPUT VOLTAGE OF EITHER UNIT PROVIDED THAT THE RATED OUTPUT VOLTAGE OF EITHER UNIT IS NOT EXCEEDED.
2. THE DIODES (CR1 & CR2) SHALL HAVE A FORWARD CURRENT RATING EQUAL OR GREATER THAN THE POWER SUPPLY OUTPUT RATING. WIRE DIODES AS SHOWN, OBSERVING POLARITY.

SERIES CONNECTION (HIGH POWER UNITS)

FIG. 2-2B

SECTION III

THEORY OF OPERATION

3-1. GENERAL. Main Supply: Refer to Figures 3-1 and 5-1.

The power is applied to input control circuit which establishes the unit operationally and the AC is stepped down by transformer (T1) to the appropriate voltage levels. This transformer has two secondary windings namely a main and an auxiliary. High power units use two separate transformers. At this point, we are interested in the main secondary.

The semiconductor devices (CR1 to CR4) are arranged in a basic bridge configuration. The SCR's (CR1 and CR4) can be considered as On-Off switching elements of the bridge whose condition at any instant is determined by the line and/ or load requirements.

The pulsating output of the bridge is applied to a familiar smoothing circuit composed of inductor (L1) and capacitor (C1). The diode (CR5) prevents any tendency towards instability that may occur as the output current is lowered and the "value of critical inductance" becomes apparent.

The diodes (A1CR8 and A1CR9) and resistor (A1R9 and A1R10) combination across the SCR (gate to anode) helps extend the repetitive PRV rating of the controlled silicon rectifiers (CR1 and CR4) and the resistor (R1) is used to preload the unit at all times, thus aiding the regulation.

Two meters (M1 and M2) are provided for monitoring the output current and voltage respectively. Meters are not provided on ETC models. The error sensing amplifier PC board has elements brought out to the positive and negative legs of the supply. The combination of resistors (R2 and A2 R14) form part of the divider used for sampling the error and the capacitor (A2C6) is used to shunt any rapid load changes around the resistors in order to speed up the required changes. The capacitor (C4) provides additional filtering for the secondary circuit supply.

The variable resistor (A2 R17) and capacitor (A2 C4) are part of the active feedback network and the error sensing amplifier PC board. Its principle use is for oscillation suppression especially in the low frequency region, and is set at the factory for optimum operating conditions. The 96PC board circuitry senses the error that appears across supply output and provides correcting information to the 95PC board. The 95PC board in turn controls the conduction time of the SCR required to return the supply to the desired level.

3-2 DETAILED CIRCUIT DESCRIPTION OF THE 96PC BOARD.

3-2.1 Secondary Regulator- A means must be provided for deriving a constant current source for the reference diode (A2CR1) and this is accomplished as follows:

The error sensing resistor divider consisting of (A2R5) and (A2R13) is used by the secondary regulator consisting of transistors (A2Q2, A2Q4, A2Q5) for sampling line and/or load changes.

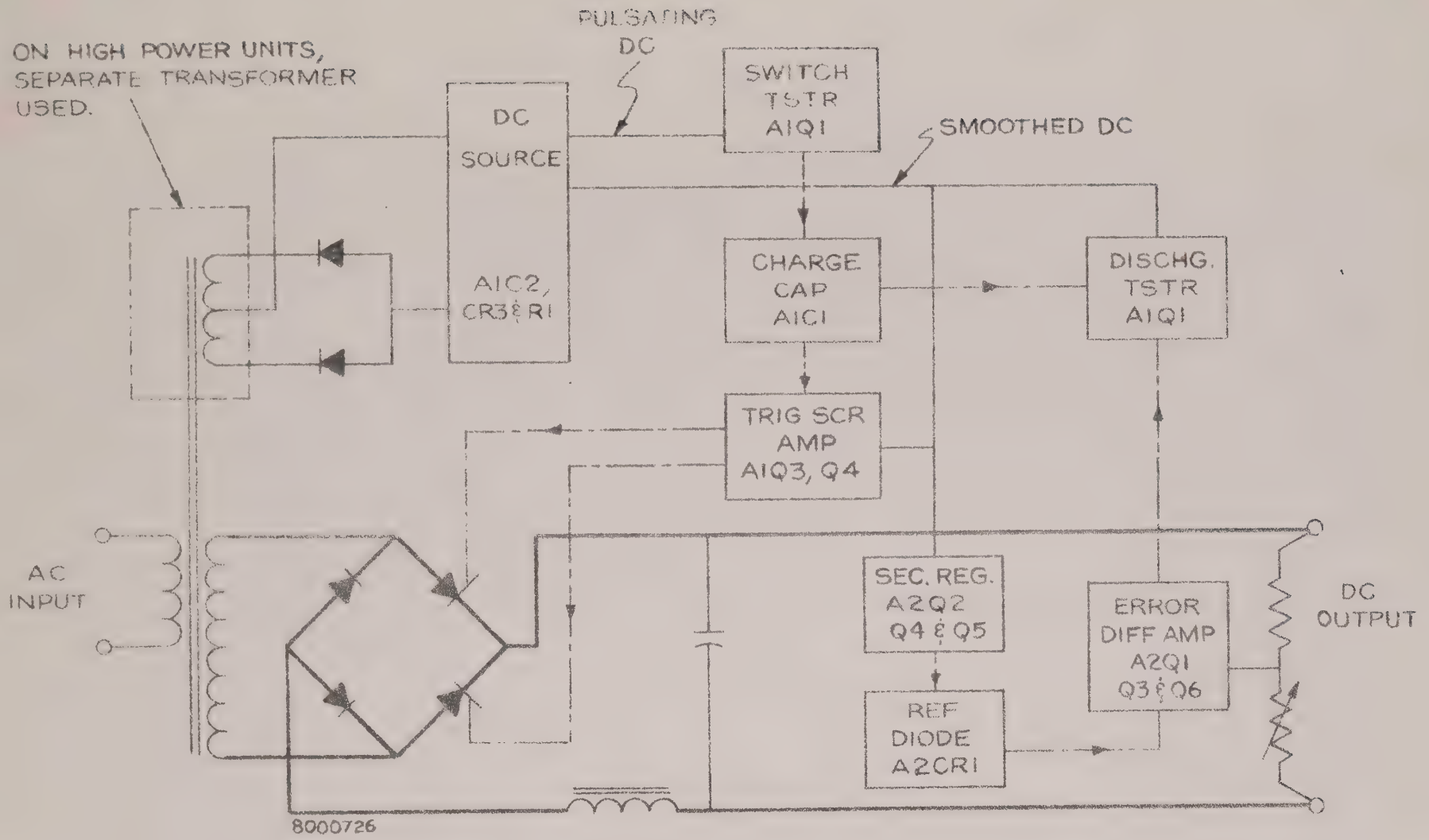
The base of transistor (A2Q4) is driven by the error-difference while the base of transistor (A2Q2) is held constant by virtue of the reference diode (A2CR1). This difference is amplified by transistor (A2Q2) and applied to the base of the series regulator transistor (A2Q5). The main advantage gained from this NPN to PNP arrangement of the transistor (A2Q2 and A2Q4) is complementary compensation against drifting due to temperature changes.

The collector load of the transistor (A2Q5) is the stabilized source required for the reference diode (A2CR1).

3-2.2 Error Amplifier- The base of transistor (A2Q6) is arranged to sense the error difference between the reference voltage developed across the breakdown diode (A2CR1) and the sampled voltage derived from the divider string resistors (A2R10, A2R14, A2R15 and R2). The error-difference is amplified and applied to the base of the emitter follower transistor (A2Q3). This arrangement transforms the error-difference to a relative low source impedance for practical application by the discharge transistor (A1Q2). The resistors (A2R2 and A2R3) are the output load elements for the transistor (A2Q3 and A2Q6). The resistor (A2R11) inserted in the base of transistor (A2Q6) is primarily used to adjust the gain of the error amplifier and at the same time this aids in stabilizing the circuit. The capacitor (A2C3) is used to suppress any tendency toward high frequency oscillation in this part of the circuitry.

Another refinement added to the error-difference circuit is the active degenerative feedback network consisting of the transistor (A2Q1) capacitor (A2C4) and variable resistor (A2R17) placed in the feedback loop of the transistor (A2Q6) base and collector.

The feedback transistor (A2Q1) is an emitter follower arrangement in order to provide a low source impedance. The resistor (A2R1) is the output load resistors for developing the required feedback power which is practically decoupled from the driving source transistor (A2Q6).



FUNCTIONAL BLOCK DIAGRAM

FIG. 3-1

CONTROL SIGNAL PATH ——— - - - -
POWER SUPPLY ═══
SECONDARY POWER PATH ———

3-2.3 Turn On Overshoot Suppression- The network consisting of transistor (A2Q7), capacitor (A2C2) resistors (A2R7, A2R9 and A2R15) is designed to minimize the output voltage overshoot whenever the power supply is initially energized and in addition it tends to reduce the peak-in rush currents.

For a very short interval after the AC ON switch (S1) is energized the uncharged capacitor (A2C2) appears as a virtual short-circuit element across the base to collector of the transistor (A2Q7). This transitory condition places the emitter element of the transistor (A2Q7) potentially very close to the collector. From this emitter (A2Q7) point, the base of transistor (A1Q1) is shifted potentially toward "turn off".

3-3 DETAILED CIRCUIT DESCRIPTION OF THE 95PC.

Refer to Figure 3-2 and 5-1 for SCR triggering.

The discussion that follows the period during one cycle (0° to 360°) of the power line frequency. During this period various transistors operating points are changing. The entire operation is synchronous with power line frequency.

This is a very important factor to remember in troubleshooting since a departure from this condition is usually a positive indication of malfunction.

3-3.1 Auxiliary DC Supply- The power transformer (T1) or separator transformer provides an auxiliary source of power for operating the various transistors and control elements. The stepped down AC voltage is applied to the full wave rectifiers (A1CR1) and A1CR2) and a pulsating DC source is produced across the load resistor (A1R1) and smoothed DC across the capacitor (A1C2) which has the pulsating component of the DC source decoupled by diode (A1CR3).

3-3.2 Switching Transistor- The pulsating DC developed across the input load resistor (A1R1) of the switching transistor (A1Q1) will provide the periodic turn on and turn off of the charging voltage for the capacitor (A1C1) and is shown as waveform (B) on Figure 3-2. The charging period is synchronous with the line frequency. The operating level of the transistor base (A1Q1) is shown in Figure 3-2 as (C).

3-3.3 Time Base- The time base capacitor (A1C1) has the transistor (A1Q2) element in the discharge path and this transistor can be considered as a variable resistor element under the control of the error amplifier transistors (A2Q3 and A2Q6). The overall charging and discharging waveform is shown as (D) on Figure 3-2.

The condition of transistors (A1Q2) as determined by the error, will in turn set the discharging rate of capacitor (A1C1). When the supply needs more power, the slope of the discharging rate will move in the direction of Slope #1. of Figure 3-3 and when less power is required the rate will move toward Slope #2.

The "turn on" instant of transistor (A1Q4) as expressed in terms of degree will vary as seen in Figure 3-3 illustration marked as level (E).

The base of the trigger transistor (A1Q4) is tied to charging capacitor (A1C1) and when the discharge (as measured from reference) on this capacitor reaches level (E) of Figure 3-2 or 3-3, the transistor (A1Q4) is turned on. A pulse is derived on the collector of transistor (A1Q4) and is coupled to the gate of the SCR, the base of transistor (A1Q2) and the base of transistor (A1Q3) simultaneously. The pulse to the bases of the two transistors causes a regenerative effect on the pulse by shifting the operating points of the bases toward the "turn on" direction. This combination has the effect of "speeding up" the trigger pulse and also shaping it.

Resistors (A1R7) and (A1R8) aid in balancing the load distribution between the two gates and insuring the proper firing of both SCR.

A complementary transistor (A1Q3) is placed in emitter load of transistor (A1Q4) for general stabilization purpose. The capacitor (A1C3) overrides this feature momentarily during the triggering period by shifting the operating point of the base of transistor (A1Q3) as described above.

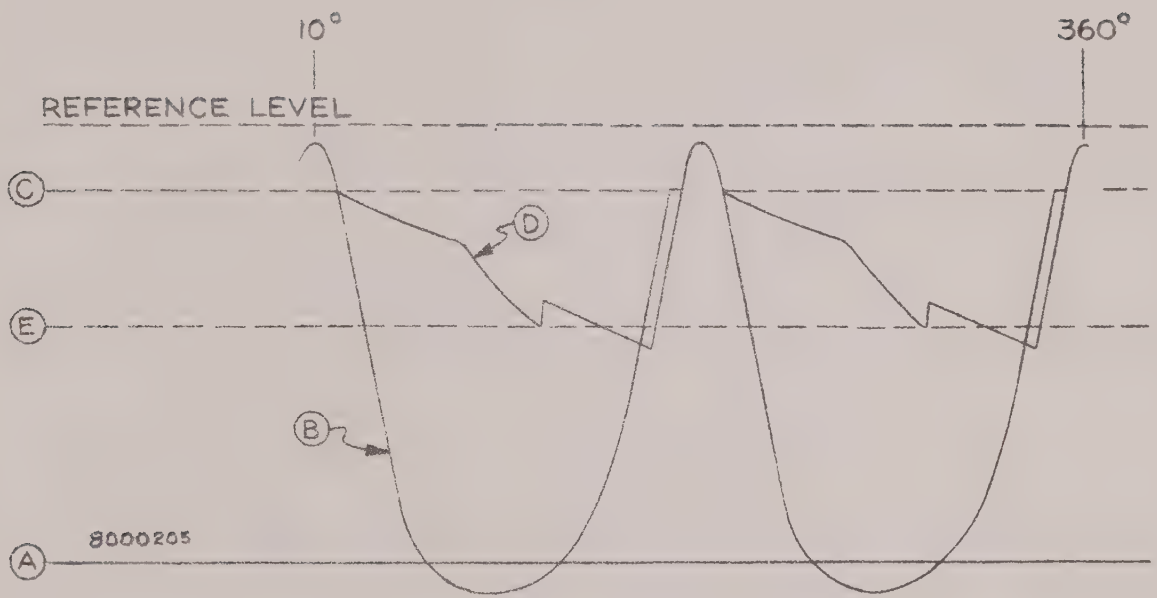


FIG. 3-2

WAVEFORMS CROSS-REFERENCED WITH THE TRANSISTOR OPERATING LEVEL

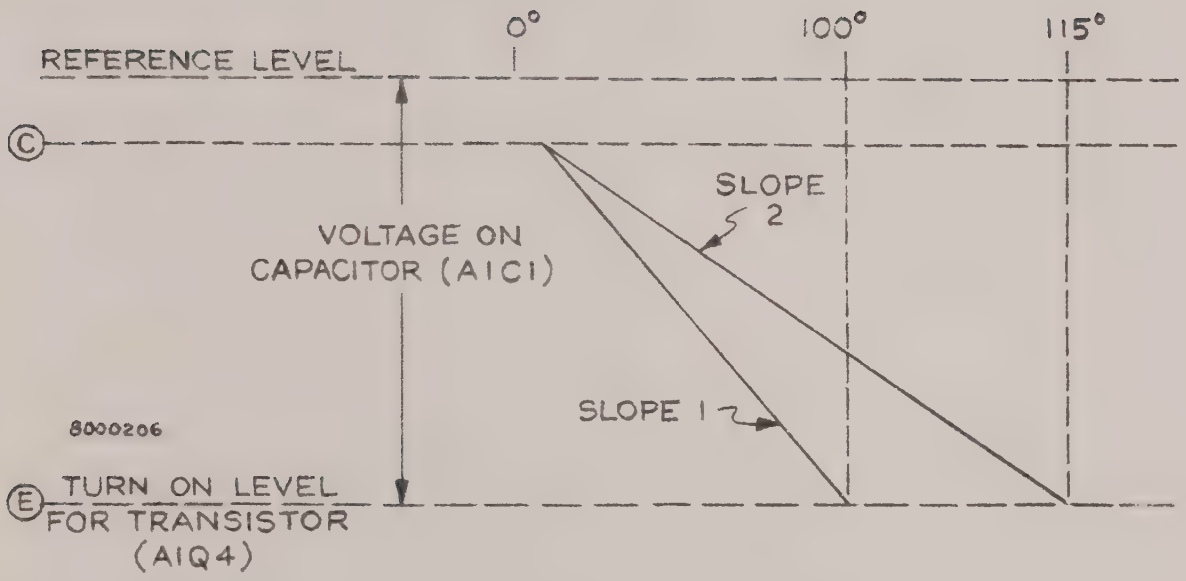


FIG. 3-3

DISCHARGING SLOPE OF TIME BASE CAPACITOR

SECTION IV

4-1. GENERAL: This supply is designed for stable operation over long periodes of time. However, if trouble develops, standard test equipment normally found in the Electronic Laboratory would be required. If the customer decides to do complete servicing on his premise, one or more of the following pieces of test instruments are required.

Instrument	Range	Remarks
DC Differential Voltmeter	0-500V	Precise regulation check.
Oscilloscope	General Purpose	General troubleshooting
Multimeter (Ohmmeter)		General troubleshooting
AC Voltmeter (Precision)	0-150V	Precise regulation check
Variable Autotransformer	0-140V AC 8 VA	General troubleshooting
Dummy Load	Range depends on supply rating	

WARNING!!

THE POWER SUPPLY SHALL BE DE-ENERGIZED WHENEVER ANY COMPONENTS ARE REPLACED.

4-2. PREVENTATIVE MAINTENANCE- The principle item that will require attention is the cooling arrangement. The power supply generally requires some amount of convection air currents for cooling purposes. The high power units have forced air cooling. If the air currents are dust laden, a problem will arise that can lead to premature component deterioration.

This condition reduces the cooling efficiency of the supply. We therefore recommend a periodic cleaning if dusty climate prevails.

CAUTION!!

VACUUM CLEANER MAY LOOSEN THE SMALL PLUG IN TRANSISTORS.

4-3 TROUBLESHOOTING- There are various types of troubles possible with this supply. The following procedure tabulates the most likely types of trouble.

NO OUTPUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Fuse blown	C1 shorted CR1 to CR4 defective	
Fuse not blown	CR5 defective or 95PC or 96PC subassembly	Check if SCR has been "turned off" by either printed circuit board.

LOW VOLTAGE OUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Voltage movable	Defective reference diode A2CR1 Defective R2 or A2R19	
Voltage stability low	95PC or 96PC subassembly defective Defective A2C6	Check if SCR has been partially "turned on".

HIGH VOLTAGE OUT

SYMPTOM	POSSIBLE CAUSE	REMARKS
Constantly high voltage	95PC or 96PC	Check if SCR has been permanently "turned on".

NO REGULATION

SYMPTOM	POSSIBLE CAUSE	REMARKS
Do not operate unit until the sensing terminals are checked for proper connections.		

POOR REGULATION

SYMPTOM	POSSIBLE CAUSE	REMARKS
Regulation poor under load or line changes	Defective CR1 to CR2 Defective transistor on 95PC or 96PC subassembly	

4-4. REGULATION CHECK. Because of the inherently slight regulation exhibited by this power supply, it is impracticable to make a regulation check by observing a voltage measurement across the output terminals of the supply as the line or load is varied.

4-4.1 To accurately check the regulation, it is necessary to use an external source of DC voltage of approximately the same value as the power supply output, connected as shown in Figure 4-3. The sensing leads shall be connected as close to the load as possible. If the load connecting leads are very short the sensing may be jumpered at the rear of the unit. This DC bucking voltage can be either an electronic unit, null balance differential voltmeter, or a group of batteries connected in series, furnishing a DC potential larger than the output voltage of the power supply under test. The voltmeter (very high impedance) should have a full-scale range of 0 to 5 or 10 volts (5-0-5 with center zero, if available), since it will be used to measure only the difference between two almost equal voltages. The balance adjustment is used to bring the meter needle to approximately midscale before testing, so that the deviation above or below the normal output of the supply under test can be observed.

4-4.2 The dummy load (R1 of Figure 4-3), is selected to draw full load current at the nominal output voltage of the supply. The difference between the differential voltmeter readings with the switch open and closed (allowing the needle to come to rest before reading), gives the static load regulation in volts.

4-4.3 Dynamic regulation is measured by substituting a calibrated oscilloscope for the differential voltmeter, and measuring the maximum deflection as a dummy load of appropriate value is switched in and out of the circuit.

4-5. ERROR-DIFFERENTIAL AND SECONDARY REGULATION AMPLIFIER CHECK- There are several methods which can be used in checking the performance and condition of these amplifiers.

Except for individually removing the transistors for a check by means of a transistor test set, and making continuity and resistance tests on the circuit and components, all methods require the amplifier to be energized with the proper potentials under the conditions found in the power supply for normal operation. For this reason, it is simplest to test the amplifier in position in the supply, first making certain that its DC power supply transformer (T1), or seperate transformer semiconductor devices, (CR1 to CR4), diodes (CR6 and CR7) and resistor (R1) are functioning properly. This can be quickly ascertained by checking the circuit voltages on the schematic diagram. Once this is done, the procedure given below can be used to check out the amplifier itself.

4-5.2 Signal Tracing Check- Since there is an inherent amount of ripple at the input of the amplifiers, this ripple signal can be used as a test signal for observing the amplifier performance with the aid of a test oscilloscope. (Ignore any spikes in the waveform). Use only the basic ripple signal when making amplitude calculations.) In the event that the ripple is too small for practical use, a small 60-cycle sine wave voltage of convenient amplitude (less than 0.25 volt) can be injected into the secondary regulator amplifier by applying it to the base of transistor (A2Q4) on printed circuit board, located on the 96PC. Measurement of the ripple at the input to the amplifier, and at the output of each successive amplifier stage will provide an effective check of amplifier performance. The ripple amplitude measured at the base (or input) of the second stage transistors (A2Q5) should be 20 to 40 times the amplitude at the input to the first stage. Radical departure from this set of conditions will point up a defective component or connection, which can then be isolated by inspection and individual test. Be sure not to overdrive the amplifier stages as it will cause misleading results.

In a manner similar to above, apply a small 60-cycle sine wave voltage of convenient amplitude (less than 0.25 volt) to the base of transistor (A2Q6). The ripple amplitude measured at the base of transistor (A2Q3) should be 20 to 40 times the amplitude at the base of the first stage transistor (A2Q3). The ripple at the emitter of the transistor (A2Q3) will be almost identical to the base ripple. This is an emitter-follower stage.

As above, any radical departure from this set of conditions will point up a defective component or connection, which can then be isolated by inspection and individual tests. Be sure not to overdrive the amplifier stages as this will cause misleading results.

4-6. STABILITY CHECK-. A detailed check for improper drift and intermittent failure can be made by utilizing a test arrangement similar to that shown for regulation check in Figure 4-3. The voltage across the breakdown diode reference source (A2CR1) is "bucked out", and monitored by a 0 to 1-volt (or smaller scale, if available) high impedance DC voltmeter (null balance voltmeter). Drift or random instability will be readily visible in this test. Output voltages of the successive amplifier stages can then be monitored in the same manner. When checking a given amplifier stage by this method, the output of the previous stage should be shorted, to prevent external voltage variations from reaching the stage under test. This does not include shorting the output terminals of the power supply. Care must be exercised to guard the load circuit from extraneous fields. When installing a new transistor in place of one shown to be defective, the stability check should be repeated to make certain that the trouble has been eliminated.

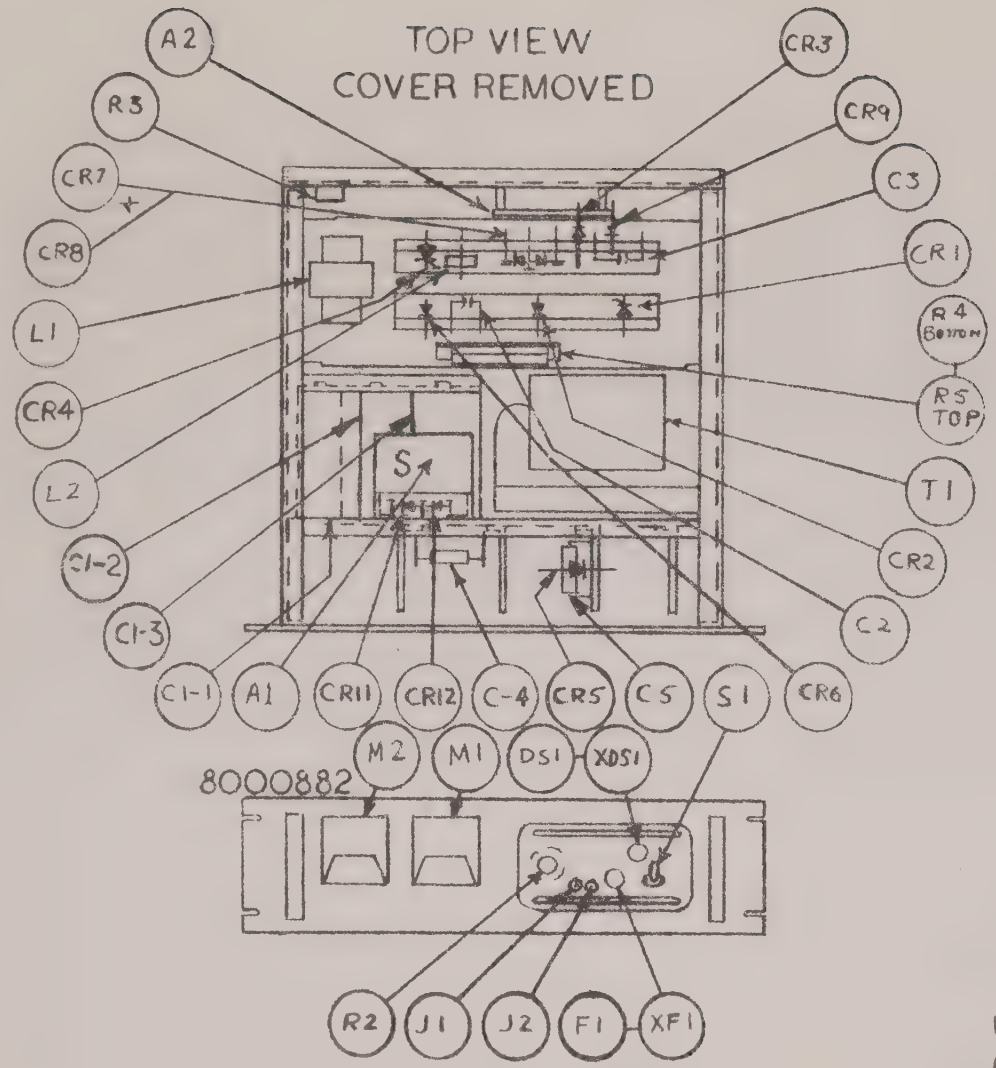
4-7. Alignment and Adjustment- The power supply has two controls that are factory adjusted and normally do not require attention in the field. If any of the components in the error-difference amplifier is replaced the following procedure shall be followed.

Step 1: Set OUTPUT ADJUST variable resistor (R2) completely clockwise.

Step 2: Set input AC line voltage to low line of 105 V AC.

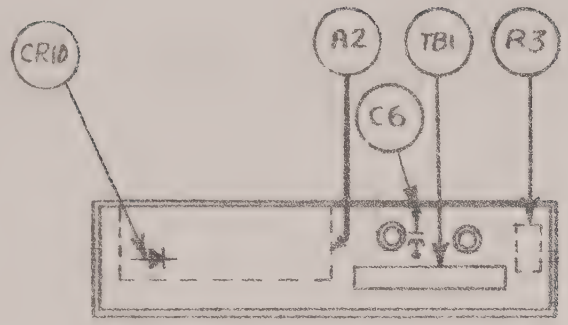
Step3: Load output of unit for full rated current and voltage.

Step 4: Adjust variable resistor (A2R10) until full rated output is reached.



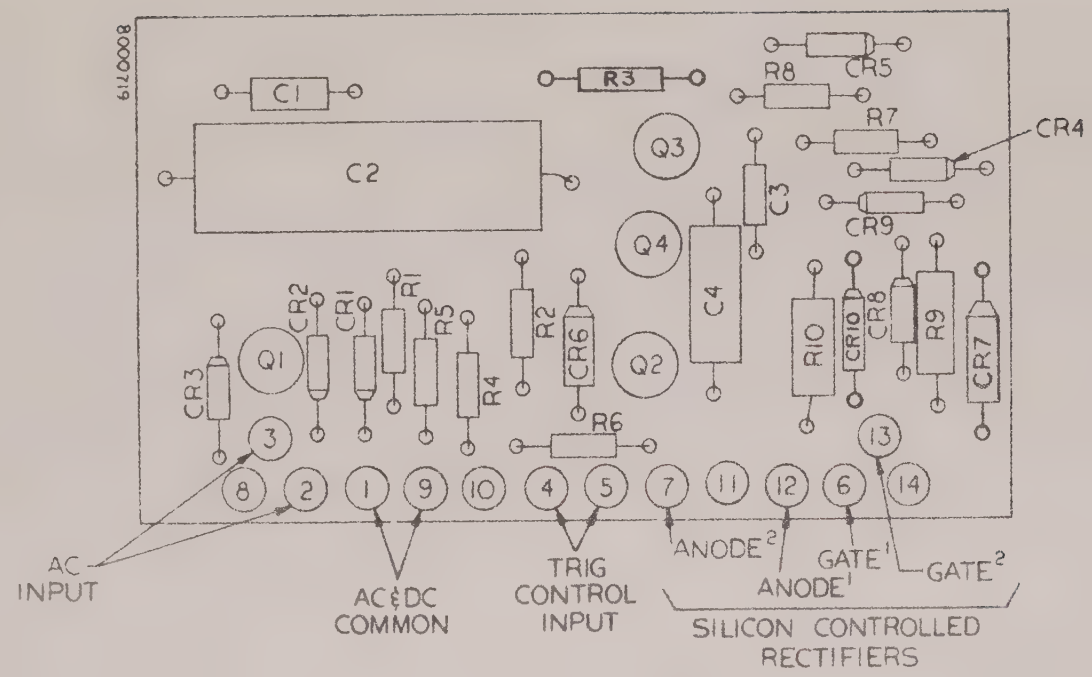
PARTS PLACEMENT
MAJOR COMPONENTS
FIG. 4-1A

NOTES: 1. CR10, CR11, CR12 USED ON TC100-6A. ONLY. 2. M1, M2, M3 NOT USED ON ETC. MODELS

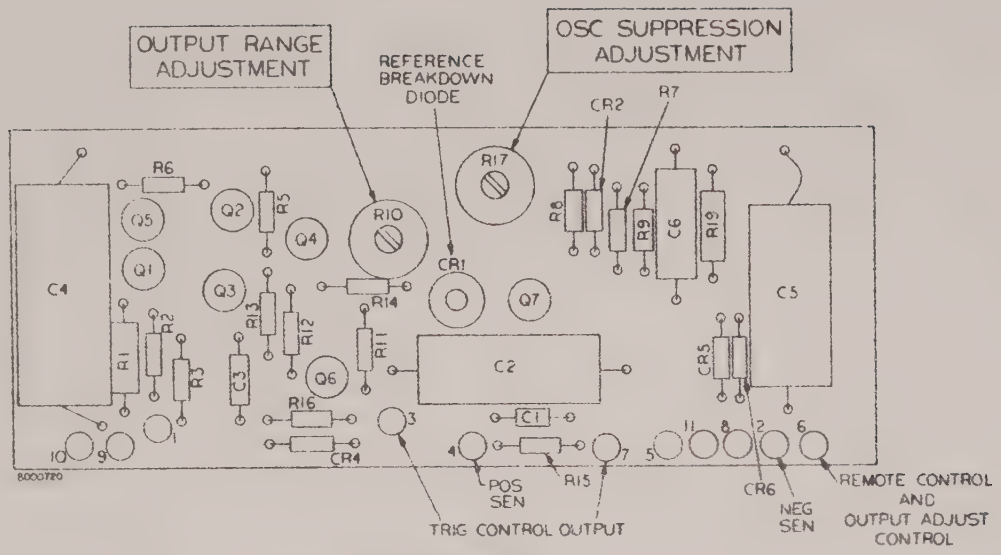


REAR VIEW

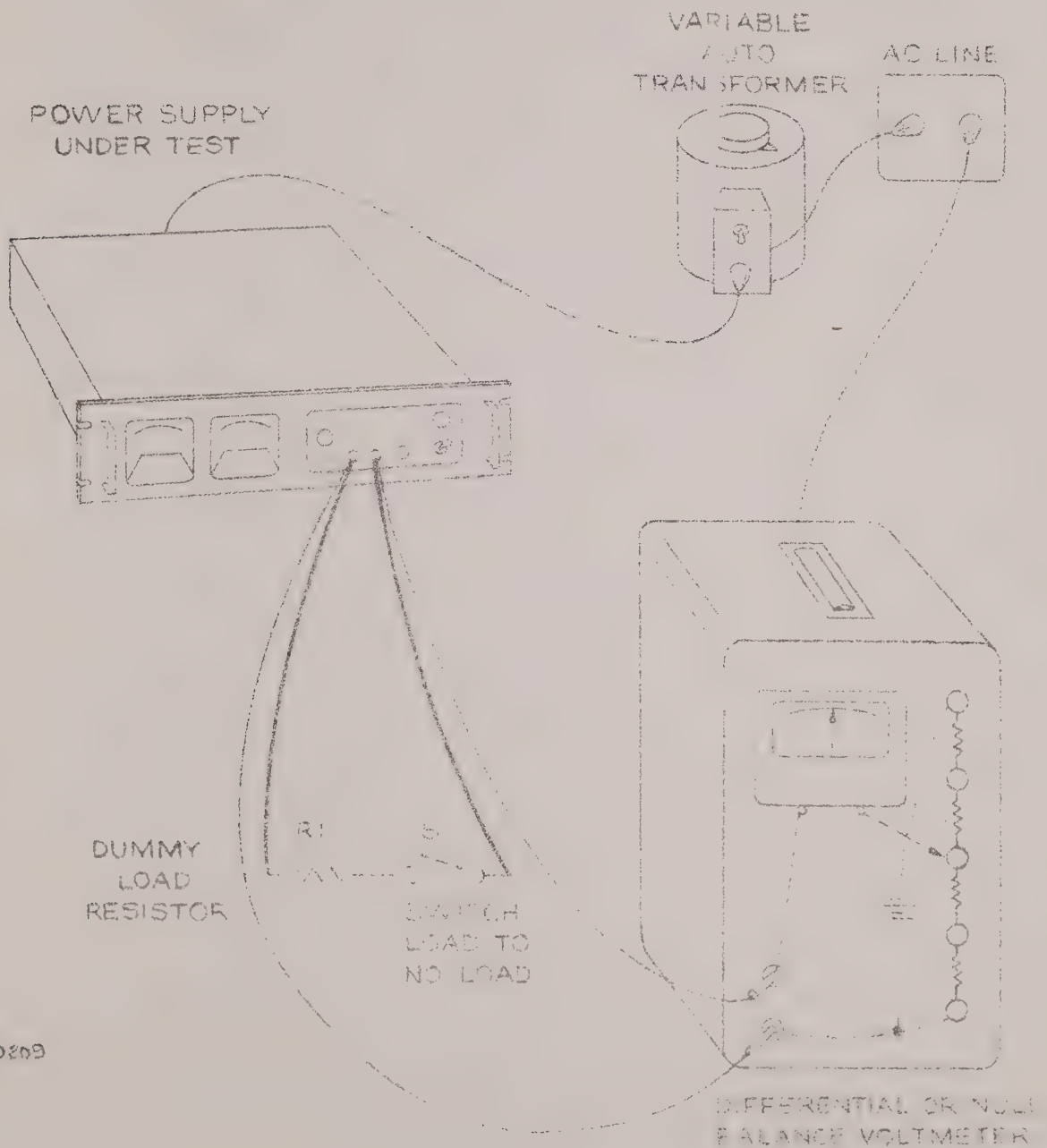
PARTS PLACEMENT
MAJOR COMPONENTS
FIG. 4-1 B



PARTS PLACEMENT
SCR TRIGGER AMP SUBASSEMBLY (95 PC)
FIG 4-2A



PARTS PLACEMENT
ERROR AMP SUBASSEMBLY (96 PC)
FIG 4-28



(4-3)

REGULATION CHECK

NJE CORP. Kenilworth, N. J.
Replaceable Parts List

Ref Des	Description	NJE Part No.	Qty	Rec Spare	Rec Vendor
		Main Assembly E/TC 80-8			
A1	Firing Circuit 302852	95PC-5	1	1	23
A2	Amplifier 302869	96PC-7	1	1	23
C1	Cap Fixed Elect 4800MF, 100V (ea in par)	2CE-100-4800	3	1	27
C2	Cap Fixed Cer 0.1MF, 500V	1CC-500-0.1	3	1	31
C3	Same As C2				
C4	Cap Fixed	101767	1	1	23
C5	Same As C2				
C6	Cap Fixed Tant 30MF, 100V	1CT-100-30	1	1	27
CR1	Semicond Device Diode (SCR)	2N685	2	1	16
CR2	Semicond Device Diode	1N1202	3	1	16
CR3	Same As CR2				
CR4	Same As CR1				
CR5	Same As CR2				
CR6	Not Used				
CR7	Semicond Device Diode	CER 530	2	1	29
CR8	Same As CR7				
CR9	Semicond Device Diode	1N2970A	1	1	24
CR10	Not Used				
CR11	Not Used				
CR12	Not Used				

Replaceable Parts List

Ref Des	Description	NJE Part No.	Qty	Rec Spare	Rec Vendor
DS1	Indicator Lamp	1DS-115-MB-N	1	1	13
F1	Fuse Cartridge Fast Blow 12A, 250V	1FFB-250-12	1	5	6
J1	Binding Post Red	1J-R	1	1	32
J2	Binding Post Black	1J-B	1	1	32
L1	Reactor	204722	1	1	23
L2	Reactor	204737	1	1	23
M1	Ammeter 0-10 Amp see note 1	1M3-10ADC	1	1	16
M2	Voltmeter 0-100 volts see note 1	1M-3-100VDC	1	1	16
R1	Not Used				
R2	Res Var WW 10^{K} ± 20%, 2W	1RVW-2-10K-N	1	1	9
R3	Not Used				
R4	Res Fixed WW 300 ± 10%, 50W	1RFW-50-300	2	1	33
R5	Same As R4				
S1	Switch Power	1SW-SPST	1	1	19
T1	Transformer	204732	1	1	23
TB1	Terminal Board	1TB-10-12	1	-	8
XDS1	Lampholder	1XDS-R	1	-	13
XF1	Fuseholder	1XF	1	-	6

Replaceable Parts List

Ref Des	Description	NJE Part No.	Qty	Rec Spare	Rec Vendor
		Firing Circuit Subassy (A1) (95PC-5)			
C1	Cap Fixed Tant 2.2MF, 15V	1CT-15-2.2	1	1	27
C2	Cap Fixed Elect 500MF, 15V	3CE-15-500	1	1	27
C3	Cap Fixed Cer 0.47MF, 25V	1CC-25-0.47	1	1	31
C4	Cap Fixed Paper 0.02MF, 200V	1CP-200-0.02	1	1	27
CR1	Semicond Device Diode	CER 530	7	3	29
CR2	Same As CR1				
CR3	Same As CR1				
CR4	Same As CR1				
CR5	Same As CR1				
CR6	Not Used				
CR7	Not Used				
CR8	Same As CR1				
CR9	Same As CR1				
CR10	Not Used				
Q1	Semicond Device Transistor	2N241A	2	1	16
Q2	Semicond Device Transistor	2N445A	2	1	18
Q3	Same As Q2				
Q4	Same As Q1				
R1	Res Fixed Comp 100 ± 10%, 1/2W	1RFC-1/2-100	1	1	1
R2	Res Fixed Comp 220 ± 5%, 1/2W	2RFC-1/2-220	2	1	1

Replaceable Parts List

Ref Des	Description	NJE Part No.	Qty	Rec Spare	Rec Vendor
R3	Res Fixed Comp 5.6 ± 10%, 1/2W (EB5.6)		1	1	1
R4	Res Fixed Comp 270 ± 5%, 1/2W	2RFC-1/2-270	1	1	1
R5	Same As R2				
R6	Res Fixed Comp 470 ± 5%, 1/2W	2RFC-1/2-470	1	1	1
R7	Res Fixed Comp 15 ± 10% , 1/2W	1RFC-1/2-15	2	1	1
R8	Same As R7				
R9	Res Fixed Comp 1500 ± 5%, 2W	2RFC-2-1500	2	1	1
R10	Same As R9				
XQ1	Socket Transistor	1XQ-MC	4	-	14
XQ2	Same As XQ1				
XQ3	Same As XQ1				
XQ4	Same As XQ1				

Amplifier Subassy (A2) (96PC-7)

C1	Cap Fixed Tant 1.5MF, 20V	1CT-20-1.5	1	1	27
C2	Cap Fixed Elect 250MF, 15V	3CE-15-250	1	1	27
C3	Cap Fixed Cer 0.005MF, 50V	1CC-50-0.005	1	1	31
C4	Cap Fixed Elect 100MF, 15V	3CE-15-100	1	1	27
C5	Not Used				
C6	Cap Fixed Elect 4MF, 150V	3CE-150-4	1	1	27

Replaceable Parts List

Ref Des	Description	NJE Part No.	Qty	Rec Spare	Rec Vendor
CR1	Semicond Device Diode	1N1983A	1	1	24
CR2	Semicond Device Diode	CER 530	2	2	29
CR3	Not Used				
CR4	Same As CR2				
CR5	Not Used				
CR6	Not Used				
Q1	Semicond Device Transistor	2N241A	5	2	16
Q2	Semicond Device Transistor	2N445A	2	1	18
Q3	Same As Q1				
Q4	Same As Q1				
Q5	Same As Q1				
Q6	Same As Q2				
Q7	Same As Q1				
R1	Res Fixed Comp 100 ± 10%, 2W	1RFC-2-100	1	1	1
R2	Res Fixed Comp 4700 ± 5%, 1/2W	2RFC-1/2-4700	3	1	1
R3	Res Fixed Comp 3300 ± 10%, 1/2W	1RFC-1/2-3300	1	1	1
R4	Not Used				
R5	Res Fixed Comp 2700 ± 5%, 1/2W	2RFC-1/2-2700	2	1	1
R6	Res Fixed Comp 220 ± 5%, 1/2W	2RFC-1/2-220	1	1	1
R7	Res Fixed Comp 10K, ± 10%, 1/2W	1RFC-1/2-10K	1	1	1
R8	Res Fixed Comp 330 ± 10%, 1/2W	1RFC-1/2-330	1	1	1

Replaceable Parts List

Ref Des	Description	NJE Part No.	Qty	Rec Spare	Rec Vendor
R9	Same As R2				
R10	Res Var WW 500 ± 20%, 2W	7RVW-2-500	1	1	9
R11	Res Fixed Comp 560 ± 10%, 1/2W	1RFC-1/2-560	2	1	1
R12	Res Fixed Comp 1000 ± 10%, 1/2W	1RFC-1/2-1000	1	1	1
R13	Same As R2				
R14	Same As R11				
R15	Same As R5				
R16	Res Fixed Comp 680 ± 10%, 1/2W	1RFC-1/2-680	1	1	1
R17	Res Var WW 250 ± 20%, 2W	7RVW-2-250	1	1	9
R18	Not Used				
R19	Res Fixed Comp 2700 ± 5%, 2W	2RFC-2-2700	1	1	1
XQ1	Socket Transistor	1XQ-MC	7	-	14
XQ2	Same As XQ1				
XQ3	Same As XQ1				
XQ4	Same As XQ1				
XQ5	Same As XQ1				
XQ6	Same As XQ1				
XQ7	Same As XQ1				

Parts List Notes

1. These items are not used on Model 80-8 power supply.
2. Recommended vendors are listed at the end with serial cross reference.
3. Recommended spares are for one unit for one year of isolated service.

List of Code Numbers used in
Replaceable Parts List
To Indicate Manufacturer

NJE Code No.	FSCM	Manufacturer	Location
1	01121	Allen-Bradley Co.	Milwaukee, Wis.
2	82376	Astron Co.	East Newark, N. J.
3	65149	Barber Colman Co. Controls Division	Rockford, Ill.
4	73138	Helipot (Div of Beckman Inst Inc)	Fullerton, Calif.
5	80294	Bourns Lab Inc.	Riverside, Calif.
6	94222	Bussmann Mfg (Div of McGraw-Edison)	St. Louis, Mo.
7	71590	Centralab (Div of Globe Union)	Milwaukee, Wis.
8	71785	Cinch Mfg Co. (Div of United Carr Fastetner Corp)	Chicago, Ill.
9	12697	Clarostat Mfg Co. Inc.	Dover, N. H.
10	98925	Clevite Transistor Prod (Div of Clevite Corp)	Waltham, Mass.
11	81751	Columbus Electronics Corp.	Yonkers, N. Y.
12	91637	Dale Elect(Formerly Dale Products Inc)	Columbus, Neb.
13	72619	Dialight Corp.	Brooklyn, N. Y.
14	91662	Elco Mfg	Philadelphia, Pa.
15	21520	Fansteel Metallurgical Corp.	No. Chicago, Ill.
16	09214	General Electric Co. (Rect Comp Dept Elect Comp Div)	Auburn, N. Y.
17	83125	General Inst(Div of Pyramid Elect Co.)	Newark, N. J.
18	10214	General Transistor (Western Corp)	Los Angeles, Calif.
19	83330	Herman H. Smith Inc.	Brooklyn, N. Y.

List of Code Numbers used in
Replaceable Parts List
To Indicate Manufacturer

NJE Code No.	FSCM	Manufacturer	Location
20	99942	Hoffman Elect Corp. Semiconductor Div.	El Monte, Calif.
21	75915	Littlefuse Inc.	Des Plaines, Ill.
22	04713	Motorola Inc. Semiconductor Prod Div.	Phoenix, Ariz.
23	98380	NJE Corporation	20 Boright Avenue Kenilworth, N. J.
24	06486	North Amer Elect Inc.	Lynn, Mass.
25	44655	Ohmite Mfg Co.	Skokie, Ill.
26	87216	Philco Corp. Lansdale Div.	Lansdale, Pa.
27		See 017	
28	82877	Rotron Mfg Co. Inc.	Woodstock, N. Y.
29	13327	Solitron Devices, Inc.	Norwood, N. J.
30	02111	Spectrol Electronics Corp.	San Gabriel, Calif.
31	80183	Sprague Prod Co.	North Adams, Mass.
32	58474	The Superior Electric Co.	Bristol, Conn.
33	94310	Tru-Ohm Prod (Div of Model Eng and Mfg Inc.)	Chicago, Ill.
34	96751	Nuclear Corp of Amer Chicago. U.S. Semcor Div	Phoenix, Ariz
35	05277	Westinghouse Elect Corp. Semiconductor Dept.	Youngwood, Pa.
36	83008	Standard Electrical Prod Co.	Dayton, Ohio
37	97965	Stancor Electronics Inc.	Chicago, Ill.
38	04435	Jettron Products	Hanover, N. J.
39	12954	Dickson Electronics Corp.	Scottsdale, Ariz.

List of Code Numbers used in
Replaceable Parts List
To Indicate Manufacturer

NJE Code No.	FSCM	Manufacturer	Location
40	00656	Aerovox Corp.	New Bedford, Mass.
41		See 054	
42	86684	Radio Corp of America Elect Tube Div	Harrison, N. J.
43	14655	Cornell-Dublier	Newark, N. J.
44	71436	Chicago Cond Corp.	Chicago, Ill.
45	84171	Arco Electronics Inc.	Great Neck, N. Y.
46	75042	International Resistance Co.	Philadelphia, Pa.
47	73445	Amperex Electronics Corp. Div of North American Philips Co. Inc.	Hicksville, N. Y.
48	77764	Resistance Prod Co.	Harrisburg, Pa.
49	58849	Syntron Co.	Homer City, Pa.
50	02660	Amphenol Connector (Div of Amphenol Borg)	Chicago, Ill.
51	79727	Continental-Wirt Electronics Corp.	Philadelphia. Pa.
52		See 211	
53	06778	National Resistance Corp.	Pearl River, N. J.
54	74217	Radio Switch Corp.	Marlboro, N. J.
55	93929	G. V. Controls Inc.	Livingston, N. J.
56	74545	Harvey Hubbell Inc.	Bridgeport, Conn.
57	81042	Howard Industries	Racine, Wis.
58	93410	Stevens Mfg Co. Inc.	Mansfield, Ohio
59	08730	Vemaline Prod Co.	Hawthorne, N. J.

List of Code Numbers used in
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NJE Code No.	FSCM	Manufacturer	Location
60	16758	Delco Radio (Div of General Motors Corp)	Kokomo, Ind.
61	86797	Rogan Brothers Inc. Formerly in Chicago Ill	Skokie, Ill.
62	07047	Milton Ross Co.	Hatboro, Pa.
63	07387	Birtcher Corp.	No. Los Angeles, Calif.
64	71279	Cambridge Thermionics Corp.	Cambridge, Mass.
65	88245	U.S. Eng Co. (Div of Litton Ind)	Van Nuys, Calif.
66	91506	Augat Bros Inc.	Atteboro, Mass.
67		See 005	
68	97965	Chicago Standard Trans Corp.	Chicago, Ill.
69	13605	Cutler-Hammer Inc.	Milwaukee, Wis.
70	70309	Allied Control Co Inc.	New York, N.Y.
71	52090	The Rowan Controller Co.	Baltimore, Md.
72	83851	Kurman Electric Co.	Brooklyn, N.Y.
73		See 045	
74	06228	Texas Instrument Inc.	Dallas, Texas
75	37942	P.R. Mallory & Co Inc.	Indianapolis, Ind.
76	75376	Kurz-Kasch Inc.	Dayton, Ohio
77	03877	Transitron Elec Corp.	Wakefield, Mass.
78	70563	Amperite Inc.	New York, N.Y.
79	06980	Eitel-McCullough, Inc.	San Carlos, Calif.
80	74970	E.F. Johnson Co.	Waseca, Minn.
81	72512	Harry Davies Molding Co.	Chicago, Ill.

List of Code Numbers used in
Replaceable Parts List
To Indicate Manufacturer

NJE Code Number	FSCM	Manufacturer	Location
82	77342	Potter-Brumfield (Div of Amer Machine Foundry Co.)	Princeton, Ind.
83	23826	Furnas Electric Co.	Batavia, Ill.
84	76487	James Millen Mfg Co.	Malden, Mass.
85	12357	Burndy Corp. Omaton Div	Norwalk, Conn.
86	28520	Heyman Mfg Co.	Kenilworth, N. J.
87	78553	Tinnerman Prod Inc.	Cleveland, Ohio
88	07886	National Radio Co. Inc.	Melrose, Mass.
89	99687	Raytheon Co. Equipment Div	Newton, Mass.
90	83642	Military Specifications	No Location
91	80131	Electronic Ind Assoc. (EIA)	New York, N. Y.
92	15387	Electro Windings & Components Inc.	Hillside, N. J.
93	-----	Accutronics, Inc.	Batavia, Ill.
94	76493	J. W. Miller Co.	Los Angeles, Calif.
95	30703	Industrial Timer Corp.	Newark, N. J.
96	74193	Heineman Electric Co.	Trenton, N. J.
97	56365	Square D Co.	Park Ridge, Ill.
98	91924	Minneapolis Honeywell Reg Co. Div of Micro Switch	Freeport, Ill.
99	23559	Carling Electric Co., Inc.	Hartford, Conn.